California Avocado Society Yearbook 76 (1992): 99-107.

An Effective Strategy for the Management of Greenhouse Thrips in 'Hass' Avocado Orchards

Phil A. Phillips, Ron S. Bekey, J. Blair Bailey
Cooperative Extension, Division of Agriculture and Natural Resources, University of California, Riverside, California.

An early harvest in one year can reduce scarring and loss of grade on both that season's crop and the following season's crop.

Greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouche), is so named because it is often a pest of greenhouse ornamentals. However, it has a very wide host range which includes many subtropical species such as citrus, cherimoya, guava, mango, and sapote, as well as avocado.

In the humid coastal counties of southern California, the greenhouse thrips (GHT) is primarily a pest of avocados grown within about 15 miles of the ocean. The most severe infestations have been reported in Santa Barbara, Ventura, and San Diego Counties. GHT has been causing problems in Santa Barbara county avocados for over 40 years.

On avocado trees, the location of GHT populations and their feeding injury depends on the variety of avocado. On varieties of Mexican origin, including Bacon and Zutano, the GHT feeds primarily on the leaves and rarely on the fruit. By contrast, fruit is the primary feeding site on Guatemalan varieties such as *Hass,* which makes up approximately 80% of California's commercial production. Epidermal fruit scarring caused by thrips surface feeding, results in noticeable aesthetic blemishes and downgrading of fruit quality by the packinghouses. In general, smaller fruit rind scars of up to 1/2-inch to 1/4-inch in diameter are often tolerated in the fresh avocado market. Although mostly aesthetic in nature, fruit scars exceeding 3/4-inch in diameter resulting from prolonged GHT feeding can result in economic losses of up to 50% or more to growers. These larger scars cause the fruit to be graded down from fresh market grade to processing grade. The lower processing grade fruit generally doesn't provide sufficient return to the growers to pay for growing the fruit (~ $0.50/lb.).

There is no evidence at this time to suggest that leaf scars resulting from GHT feeding cause any reduction in quantity or quality of fruit. It is believed that most healthy avocado trees produce considerably more foliage than necessary to produce high yields of top quality fruit.

Malathion has been used to control GHT for many years in Santa Barbara County. Extensive malathion treatments have only been required to attempt control of this pest since the mid-1970s. In the last year years, 75 % to 80 % of Santa Barbara's orchards have been sprayed annually, with some growers reporting over 70% fruit damaged by GHT feeding despite the pesticide treatments.

Since this chemical control strategy has been in place, several additional arthropods have risen to pest status, notably the six-spotted mite, avocado brown mite, amorbia, and omnivorous looper. Disruption of their respective natural enemies by the malathion applications is suspected, but at this time there is no good evidence to support this.

Although promising biological control agents for greenhouse thrips have been identified and imported, effective control has yet to be achieved on a large scale basis. The parasitic wasp *Thripobius semiluteus Boucek,* introduced from Australia in 1986 and Brazil in 1988, has shown the greatest potential for biological control of GHT and will ultimately be the long term solution. An additional strategy, however, is needed in the interim.

Several observations suggest that by manipulating harvest dates, avocado growers might be able to reduce GHT populations and the fruit scars they produce. Historically, damage to avocado fruits has been greatest in the northern-most avocado producing coastal counties such as Santa Barbara, where cooler temperatures allow the fruit to be held on the tree longer in anticipation of higher prices. Where fruit has generally been picked earlier in the year, such as in San Diego County, the damage has been less. The predominant variety affected by GHT is *Hass.* Since GHT resides primarily on the fruit in Hass orchards, a large portion of the population is removed each year at harvest. Thus, a cultural technique such as advancing the harvest date might be advised to control GHT.

To test this hypothesis, a trial was conducted during 1988 at the Elwood Canyon Ranch in Goleta, Santa Barbara County. The objective was to determine whether by harvesting earlier in the season GHT populations could be lessened, resulting in fewer GHT feeding days on the fruit and ultimately reducing fruit scarring levels-both in terms of percent crop scarred and in the severity of individual fruit scars.

Methods

Three different harvest dates served as the treatments: an early-season, a mid-season, and a typical late-season harvest. The test plot design consisted of six single tree replicates per treatment in a randomized complete block design. Treatments were assigned to test trees based on pre-trial GHT fruit infestation levels on the test trees assessed on June 9. Percent GHT infestation was determined by examining 13 fruit per quadrant for 52 fruit per test tree between 18 inches and 72 inches above the orchard floor for the presence of an active GHT infestation. Each test tree was surrounded by four buffer trees which were to be harvested at the same time but separately from the test trees to eliminate any possible influence of GHT populations adjacent to the harvested test trees.

1st instar (smaller, below) and pre-pupal (larger, above) stages of greenhouse thrips. Note fecal droplet on abdomen of1Ist instar nymph.
Photo by Jack Kelly Clark

Adult greenhouse thrips.
Photo by Jack Kelly Clark

GHT colony and feeding scar at bottom and sides of fruit.
Photo by Jack Kelly Clark

Blair Bailey assisting with harvest sampling
Photo by Phil A. Phillips

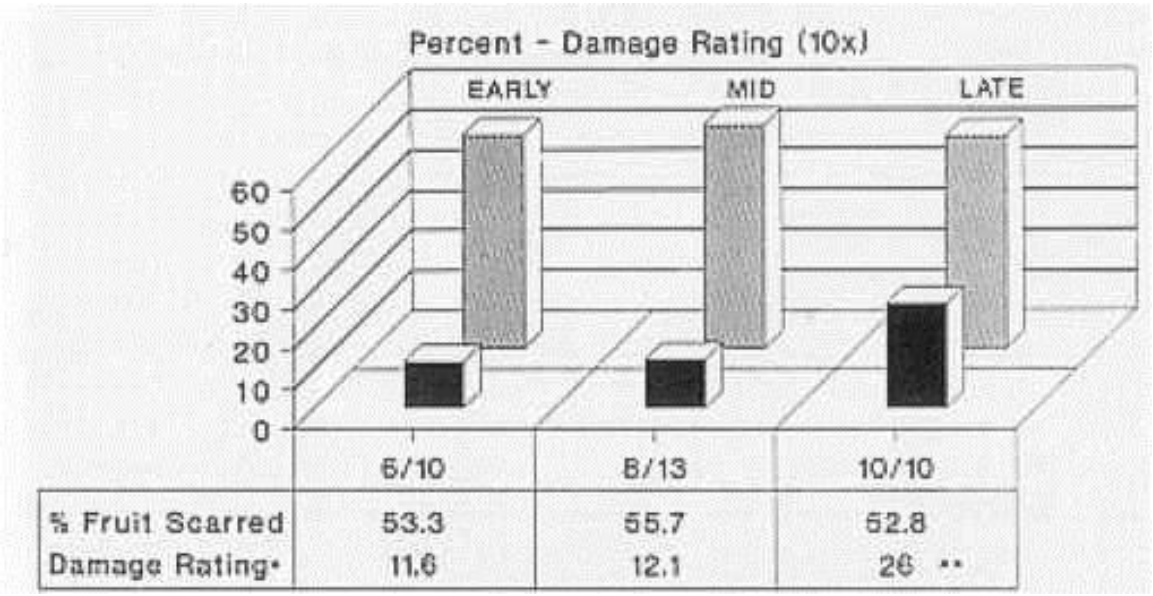
An early-season harvest of six test trees and their respective buffer trees was conducted on June 20th, 1988. A second, mid-season, harvest was similarly conducted on August 13th, while a third, late-season, harvest was conducted on October 10th. A final harvest of the following year's crop on all 18 test trees was conducted on March 29, 1989 to measure any carryover effects from the 1988 season harvest treatments. These harvests were all conducted by the regular three-man picking crew employed by the cooperating ranch. Fruit from the test trees were deposited into standard picking bins,

where a random sample of 100 fruit per tree was assessed for GHT rind scars. Each sample fruit was scored for presence or absence of and severity of GHT feeding scars. Each fruit was given a scar severity rating on a scale of 0-5, 0 being no scar, I being up to a "dime" sized scar, 2 being "dime" to "quarter" sized scar, 3 being "quarter" sized scar to half the fruit surface scarred, 4 being over half the fruit surface scarred, and 5 being completely scarred. Although not of economic size, the small scars were recorded because with continued GHT feeding at these scar sites the scars would eventually attain a size of economic importance. After scoring individual sample fruit from each test tree during each harvest at the ranch, fruit from all six test trees at each harvest was pooled and sent to a commercial packer, Calavo Growers of California, for grading. This procedure was intended to provide additional full tree crop quality information as backup to our 100 fruit sample taken from each tree's harvested crop. Since GHT tends to be very clumped in its distribution, with little lateral movement between trees in an orchard, it was felt that the buffer tree design of the experiment was not essential. Therefore, as additional backup information, fruit from the harvested buffer trees was sent to the ranch's packer, Eco Farms, for grading.

Results

During 1988, on what was the current season's crop, even though the percentage of fruit having GHT scars was similar for all three harvest dates, the late-season harvest resulted in significantly more severe fruit scarring *(i.e.,* larger individual fruit scars) than either the mid-season or early- season harvests (Figure 1). Unfortunately, the backup packing house grading data from the full crop on each test tree were incomplete due to the loss of the grading information for the final late-season harvest. However, the early-season harvest produced an 8.6% loss from GHT on the full crop from our test trees for the high value fresh market grade fruit, while the mid-season harvest resulted in an even higher loss of 15.1% fresh market grade fruit due to GHT feeding scars (Table 1). With a significantly greater percentage of fruit scarred in our late-season harvest test trees, it would be logical to assume the greatest loss in fresh market grade would have resulted at the packing house from this harvest. Again unfortunately, these packing house grade data were lost.

Current Season GHT Scars –1988
Hass Avocado



1988 Harvest Date

Damage Rating* % Fruit Scarred

* DAMAGE RATING SCALED UP BY FCTOR OF 10
** SIGNIFICANTLY LARGER SIZED SCARS
Figure 1.

When the carryover effects on the following year's crop are considered, the early-season harvest resulted in not only significantly less new crop scarring, but also in considerably less new fruit with active GHT early in the season (Figure 2). Moreover, the severity of individual scars on fruit harvested the following year was considerably greater with each delay in harvest date during the previous year (Table 2).

Discussion

Immature GHT, and to a lesser extent even adults, tend to feed in concentrated areas, with their populations building and expanding over the season out and away from the initial infestation point on the fruit. This behavior creates "islands" of activity on the fruit surface. Since GHT cannot successfully feed on older, previously fed-upon, and scarred areas of the fruit rind, these "islands" of actively feeding GHT continually move outward from the initial point of infestation onto new tissue at the periphery of the developing scar tissue. As a result, fruit rind scarring resulting from GHT feeding is cumulative over the season, ever increasing as the GHT population expands. If conditions are optimum for GHT growth and increase through the season, avocado fruits may become 100% scarred, causing the GHT to move up the fruit stem to locate new feeding sites.

Considering this GHT feeding behavior, it would seem reasonable for an early-season harvest to produce fewer thrips-scarred fruit than a harvest later in the season, as the thrips are actively feeding longer on the fruit which is harvested last.

By harvesting avocados earlier in the season, the period of crop overlap between the current crop and next year's crop is minimized. The greater the crop overlap period, as with late-season harvests, the greater the period of time allowed for GHT to establish colonies on the new crop at a very early stage in its development. This would understandably increase the damage to the following year’s crop, given favorable conditions for GHT development.

Conclusion

For the Guatemalan avocado varieties such as *Hass,* where GHT populations are concentrated on the fruit, an early harvest strategy can accomplish both a significant reduction in GHT-scarring on the current season's crop, as well as on the following season's crop. Where chronic and severe areas of GHT infestation can be identified in an orchard, the early harvest strategy should be applied to these areas, leaving the remainder of the orchard available for harvest at the optimum time where the highest market prices prevail.

Acknowledgments

The authors gratefully acknowledge the California Avocado Research Committee for partial funding of this research and Mark McKee, manager of the Elwood Canyon Ranch, for use of the orchard, the ranch's harvesting crew, and their enthusiastic cooperation.

Table 1.

6/10/88	Grade			
	#1's	#2's	Culls	Total Crop
Fruit Weight (lbs)				
Test Trees	609	98	23	730
Buffer Trees	3,137	664	23	3,824
GHT Scarred Fruit (lbs)				
Test Trees	Slight	63	--	--
Buffer Trees	Slight	498	12	510
Total GHT Impact (% Crop)				
	Drop One Grade To A "#2"		Culls	
Test Trees	8.6%		--	
Buffer Trees	13.02%		0.31%	

8/12/88	Grade			
	#1's	#2's	Culls	Total Crop
Fruit Weight (lbs)				
Test Trees	784	164	1	949
Buffer Trees	2,323	509	0	2,832
GHT Scarred Fruit (lbs)				
Test Trees	Slight	118	0	118
Buffer Trees	Slight	432	0	432
Total GHT Impact (% Crop)				
	Drop One Grade To A "#2"		Culls	
Test Trees	15.1%		0%	
Buffer Trees	15.3%		0%	

10/10/88 (DATA LOST FROM PACKINGHOUSE)

1988 Harvest Date's Influence on GHT's
Scarring of the 1989 Avocado Crop

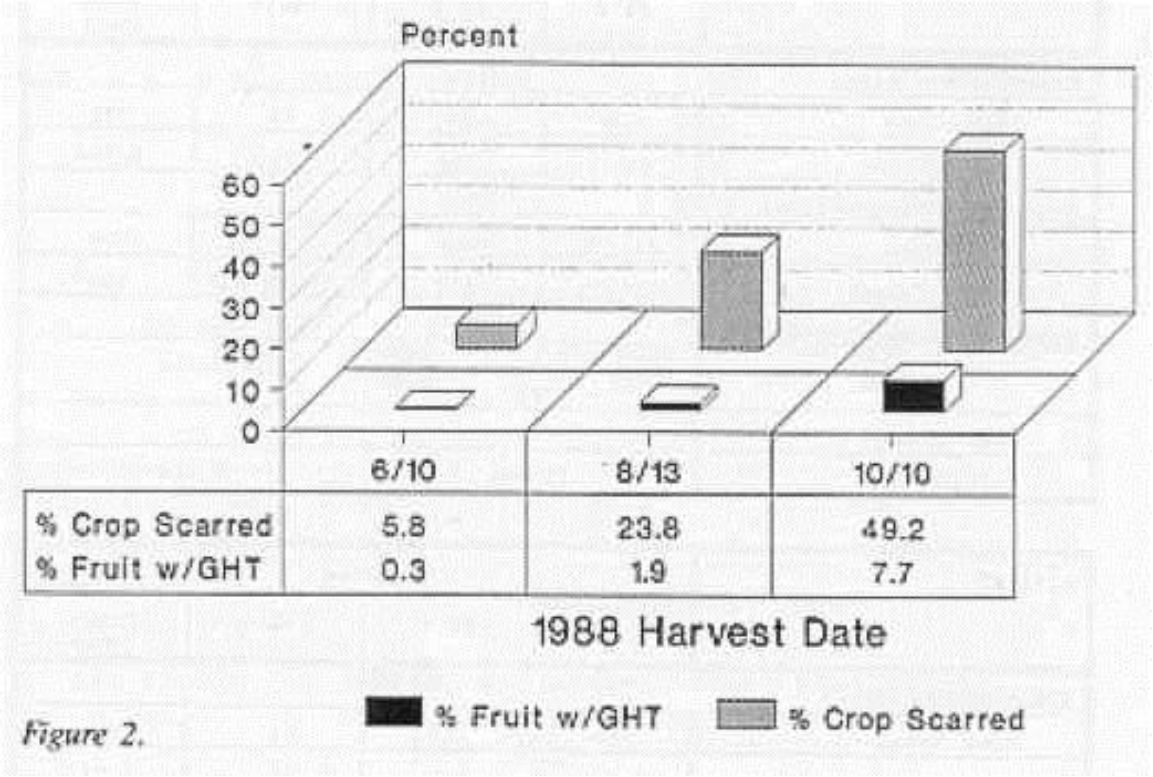


Figure 2.

Table 2.

GREENHOUSE THRIPS MANAGEMENT:
IMPACT ON HARVEST DATE ON NEXT YEAR'S CROP*

Scar Severity	(Rating)** Range	Average Scar Rating***
0.11	(0-3)	1.7
0.55	(0-4)	2.2
1.18	(0-4)	1.9

*Harvests (treatments) conducted in 1988 for impact on 1989 (3/23/89) harvest (strip picked)
** Average scar rating per fruit for entire crop. Scars rated 0 = 0, 1 = up to dime size scar, 2 = dime to quarter size, 3 = quarter size to less than h surface scarred, 4 = more than &@ scarred, 5 = completely scarred
*** Average scar rating for fruit with scars